THUNDER GROUND WAR

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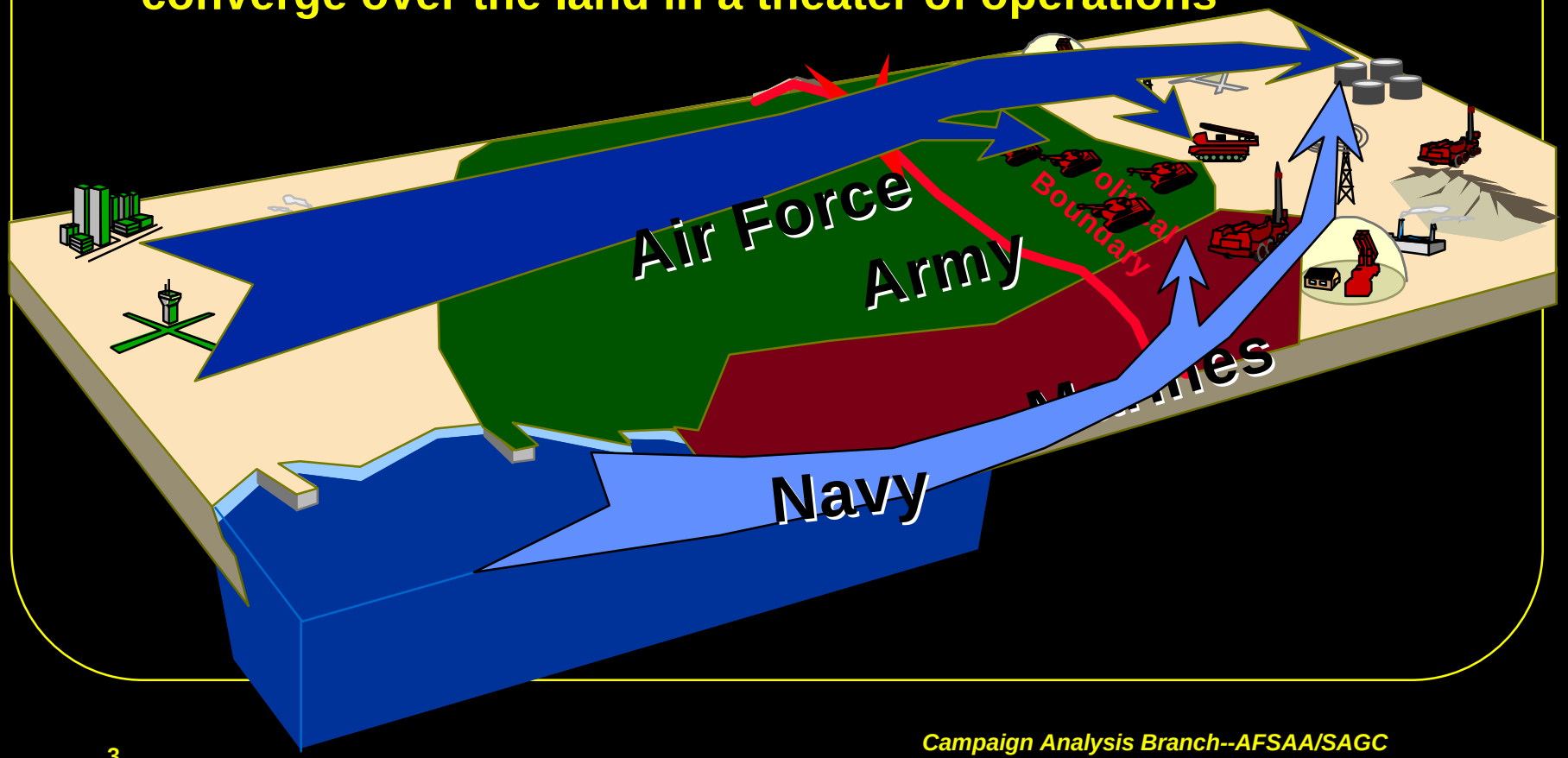
Overview

- Model Background and General Description
- THUNDER Ground War
  - Relationship to US Army Models
  - Key Concepts
- Detailed Ground War Descriptions
  - Battlefield
  - Units
  - Combat
  - FLOT Movement

THUNDER

USAF's Premier Analytical Campaign Model

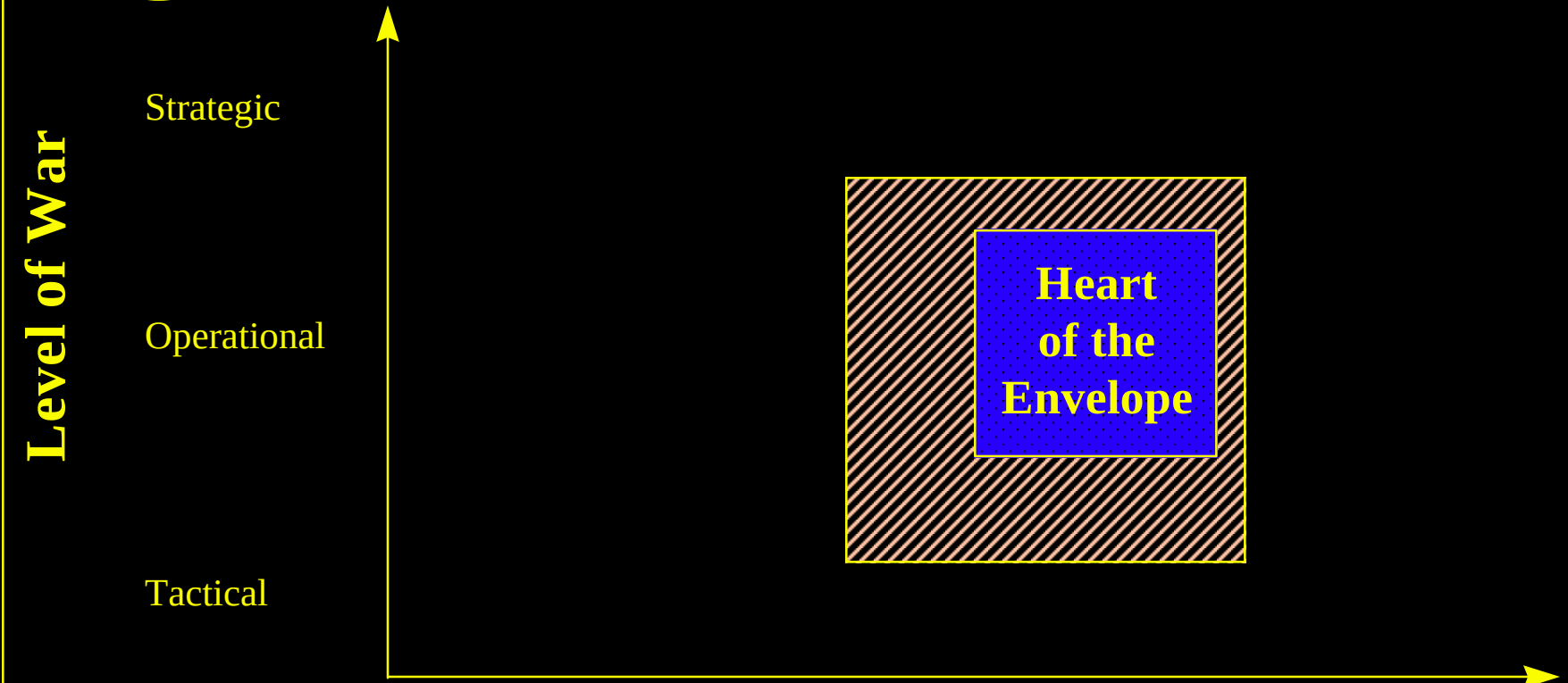
- **Foundation: Service warfighting perspectives converge over the land in a theater of operations**



THUNDER--What is it?

- Theater level model
  - Stochastic
  - Two-sided
  - Event sequenced
- Developed and managed by AFSAA
- Conventional air-land warfare
- Written in SIMSCRIPT II.5™
  - Flexible, modern simulation language
- Runs best on Sun or Silicon Graphics UNIX workstation

THUNDER Domain

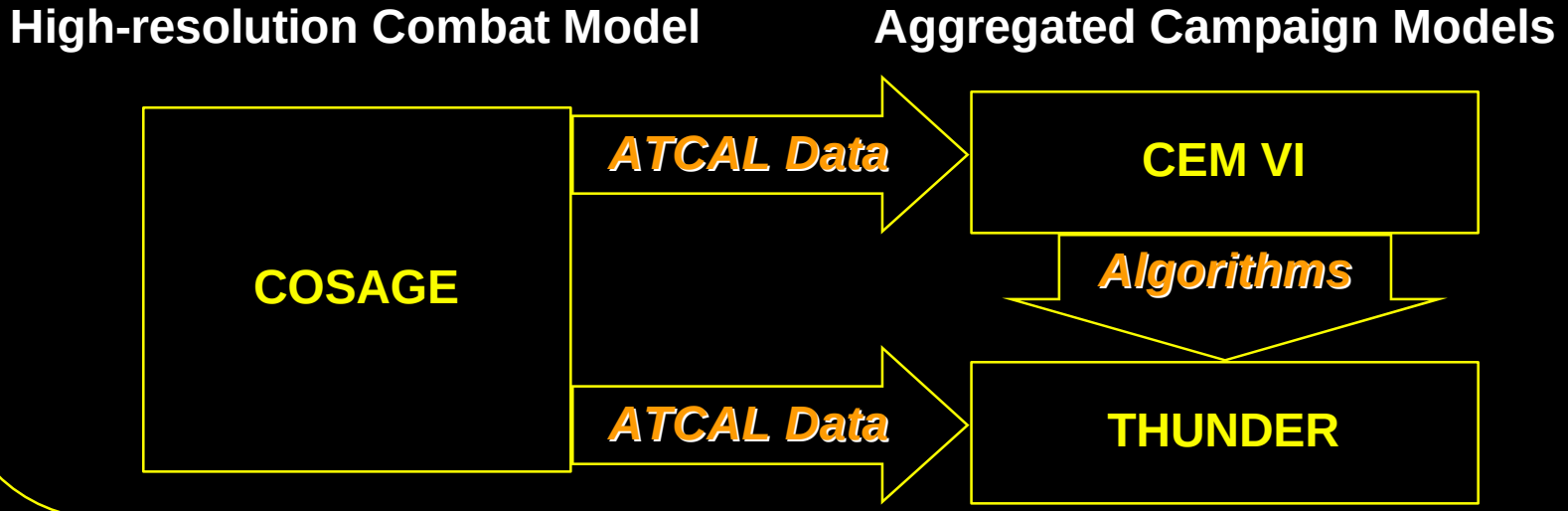


THUNDER Ground War -- Summary of Key Concepts

- THUNDER ground war based on state-of-the-art US Army campaign methodology
  - Uses "Advantage Index" parameter as basis for FLOT movement
    - » Historically valid; superior to force ratio based FLOT movement methodology
    - » Especially useful in assessing impact of asymmetric force alignments (i.e. large army vs large air force)
  - *Fundamentally different* methodology than many other campaign models currently in use
- Models impacts of disruption of command and control (C2) as well as supplies
- Models both "close-" and "deep-battle"

THUNDER Ground War Heritage

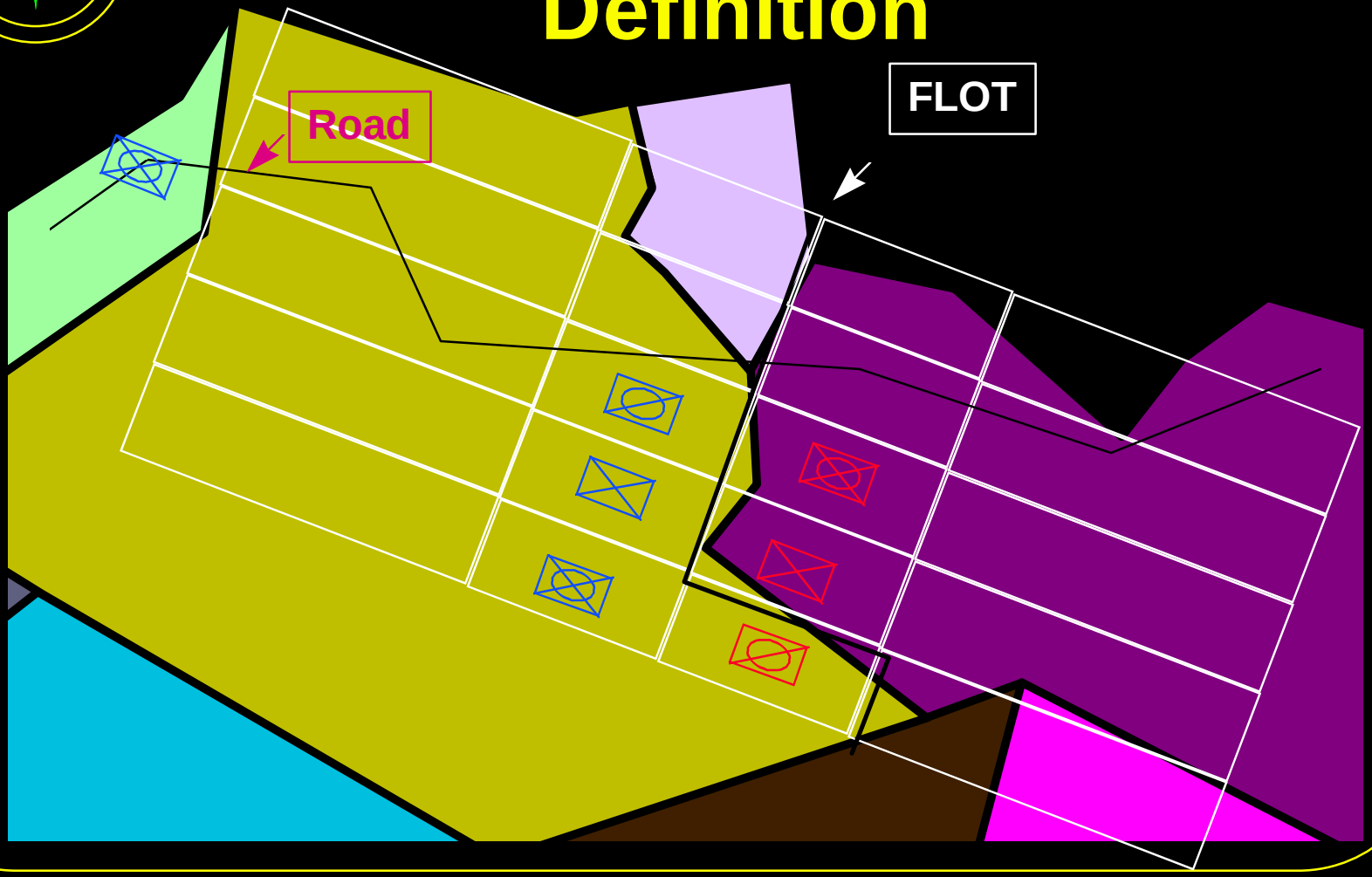
- THUNDER's ground war is based on US Army Concept and Analysis Agency's (CAA) Concept Evaluation Model (CEM VI)
- Ground vs Ground adjudication uses Attrition Calibration (ATCAL) data from CAA's Combat Sample Generator (COSAGE) model in same manner as CEM VI



Battlefield Definition

- Battlefield defined as X, Y coordinate system
- Battlefield can have road, rail, sea networks
- Ground units can move...
  - "Tactically" on battlefield
  - "Administratively" on network
- Typical size of battlefield is from 500x500 km to 2500x2500 km
- Battlefield must contain defined forward line of troops (FLOT)

Simplified Battlefield Definition



Unit Definition

- Maneuver and combat support units defined by user
  - Unit equipment (TO&E), movement rates, and supply consumption rates defined
  - Typical AFSAA scenario uses brigade-sized maneuver units and battalion sized support units
    - » Smaller units possible, but generally not played at campaign level
- Can model both single- and two-echelon army
- Units can start war on or off battlefield
- Data for US units from Service sources; adversary units from intelligence sources

Unit Status

- **Units status is determined by position and mission:**
  - **“On-line” -- maneuver unit fighting on FLOT**
  - **“Support” -- support unit near FLOT**
  - **“2nd Echelon” -- maneuver unit waiting to commit to “on-line” (Two-echelon army only)**
  - **“Holding” -- any unit waiting for orders**
  - **“Moving” -- any unit moving on network**
  - **“Withdrawn” -- any unit withdrawn from battle, normally because of attrition or lack of supplies**

Unit Movement

- Rear area movement
  - Units move on network
    - » THUNDER uses Dijkstra's algorithm to determine fastest route to destination
  - Units subject to interdiction by air attack
    - » Interdiction can delay, disrupt, and destroy units by:
      - Direct attack on unit
        - Destroy equipment
        - All attacks can induce movement delay
      - Indirect attack on network (bridges, railroad yards, ports, etc)
- "On-line" unit movement
  - Units "on-line" follow FLOT movement rules

Unit Combat Overview

At end of each combat cycle...

Determine Unit Strength

From equipment values and quantities
Degrades from C2 or supply disruptions possible

Determine Unit Posture

Based on Force Ratios
User defined rules

Enter ATCAL Tables

Data from COSAGE Model

Assess Unit Gnd-Gnd Attrition

Unit Combat

- Unit combat is based on CEM VI algorithms using ATCAL data
- Unit posture is determined by force ratio
  - Seven possible postures:
    - » RADD -- Red attack, Blue delay
    - » RADH -- Red attack, Blue hasty defense
    - » RADI -- Red attack, Blue intense defense
    - » Static -- Static for both sides
    - » BADI -- Blue attack, Red intense defense
    - » BADH -- Blue attack, Red hasty defense
    - » BADD -- Blue attack, Red delay
- Unit posture determines ATCAL coefficients for point and area fire calculations

ATCAL Point Fire Equation (Simplified)

$$(\Delta N_k)_{ij} = \bar{N}_i \, (RATE)_{ij} \, P_{ijk} \, [1 - (1 - A_{ijk})^{\bar{N}_k}]$$

where:

$(\Delta N_k)_{ij}$ = Attrition of target type k from shooter i employing weapon j

$\bar{N}_i$ = Average number of shooter i over combat cycle

$(RATE)_{ij}$ = Rate of fire of shooter i employing weapon j

P_{ijk} = Priority of target type k from shooter i employing weapon j

A_{ijk} = Availability of shooter i employing weapon j to shoot at target type k based on formula: $1 - \exp[-(range_{ij})/FLOT\ width]$

$\bar{N}_k$ = Average number of target k over combat cycle

ATCAL Area Fire (Simplified)

$(\Delta N_k)_{ij} = E_{ij} P_{ijk} (FRAC)_{ijk}$

where:

$(\Delta N_k)_{ij}$ = Attrition of target type k from shooter i employing round j

E_{ij} = Allocation of type round based on bias input from ATCAL

P_{ijk} = Kills per round type j from shooter i on target k

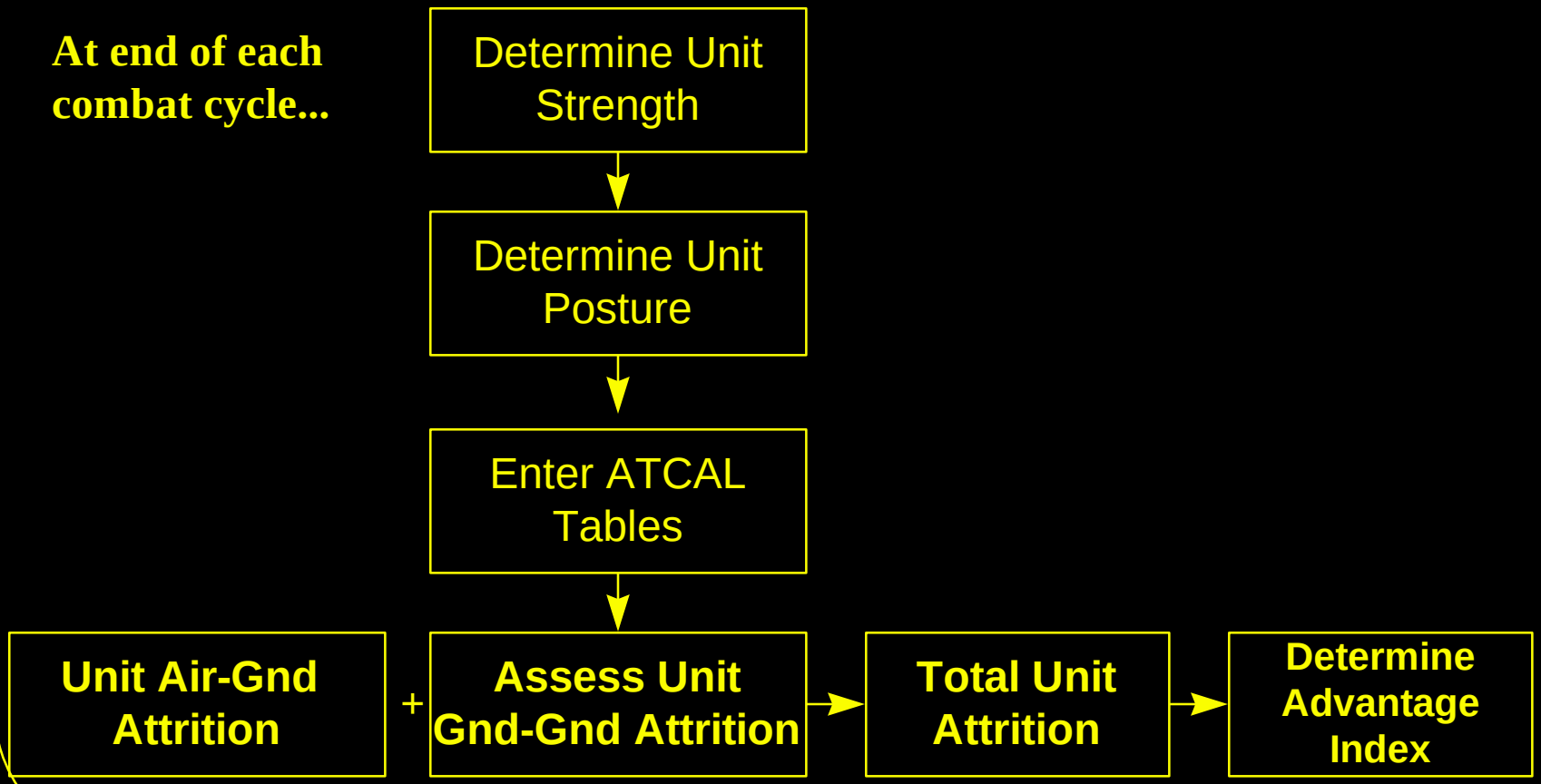
$(FRAC)_{ijk}$ = Fraction of round type j from shooter i that will attack target k (this fraction is a function of target priority, kills per round, and bias)

Unit Attrition

- Attrition of “on-line” units assessed as sum of:
  - Ground-ground attrition
    - From ATCAL
  - Air-ground attrition
    - From successful air attacks in previous combat cycle
- Attrition is measured as reduction in combat strength of a unit
  - Based on equipment value lost
- Entering value into advantage index equation

Unit Combat -- Addition of Air-Ground Attrition

At end of each combat cycle...



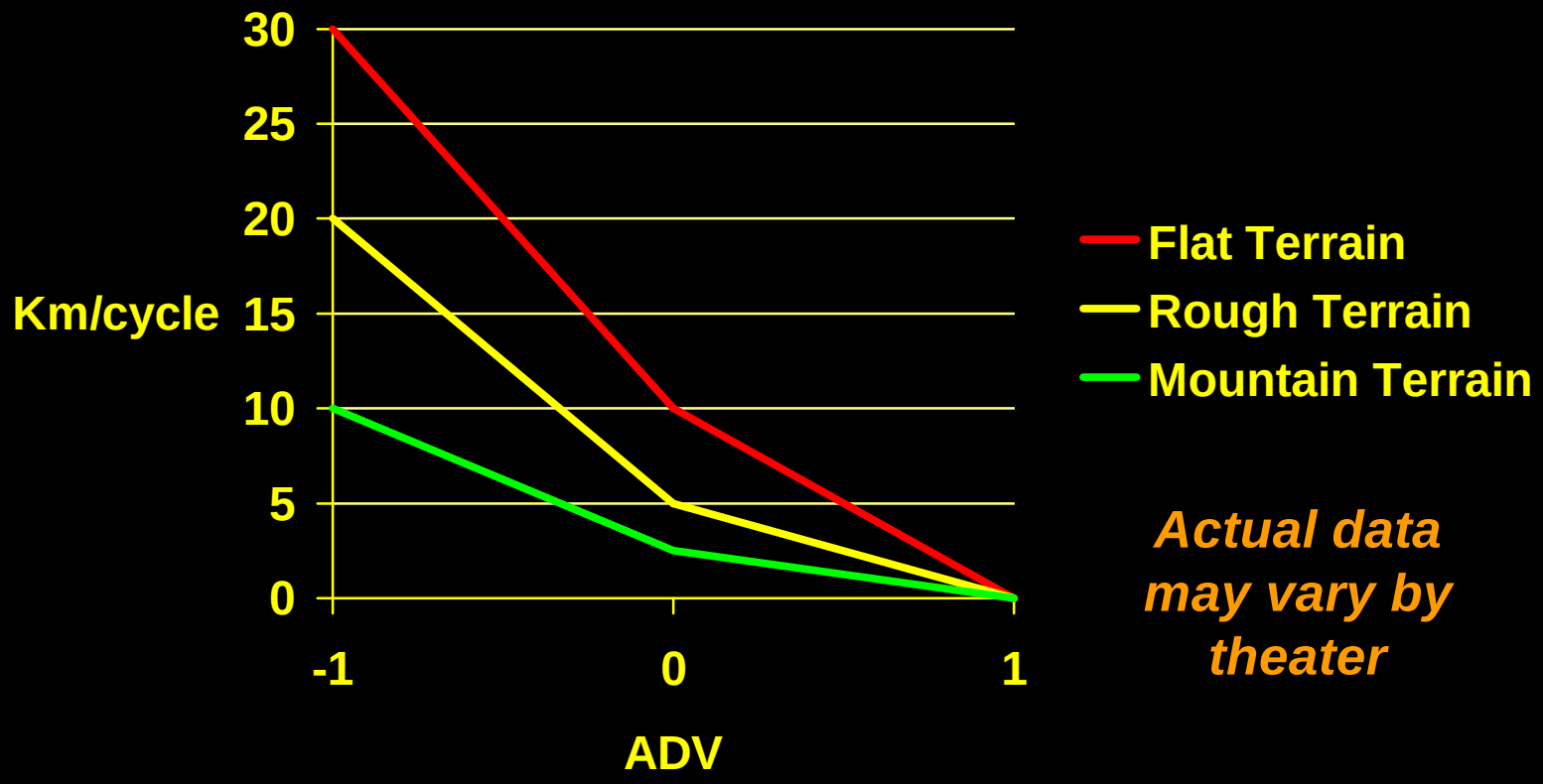
Determine Advantage Index

- **The Advantage Index parameter is determined using the following equation:**

$$ADV = \ln\left(\sqrt{\frac{1 - (\text{Attacker's Attrition})^2}{1 - (\text{Defender's Attrition})^2}}\right)$$

- **The resulting number is entered into the FLOT movement curve to reposition the FLOT**

Typical FLOT Movement Curve



Actual data may vary by theater

Comments on "Advantage Index" Methodology

- From Dr Robert L. Helmbold (CAA) after study of over 3300 battles and campaigns throughout history (including over 1100 mechanized engagements)
  - "It may be quite difficult to find a single parameter that is more closely associated with [FLOT] advance rate than ADV."
  - "...there is at best only a slight dependence of [FLOT] advance rate on force ratio."

Helmbold, Robert L., "Rates of Advance in Historical Land Combat Operations", US Army CAA Research Paper No. CAA-RP-90-1, 1990

Conclusion

- **THUNDER Ground War based on State-of-the-Art US Army Campaign Model (CEM VI)**
- **THUNDER Ground War uses "Advantage Index" parameter as basis for FLOT movement**
  - ***Fundamentally different* methodology**
  - **Particularly suited to capturing the effects of Airpower**

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